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(54) **Fluid homogenization**

Homogenisieren von Fluiden

Homogénéisation de fluides

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- **PATENT ABSTRACTS OF JAPAN vol.14, no.14 (C-674)(3957), 12 January 1990;**

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Description

The invention relates to the homogenization of a liquid and a gas.

The invention has particular application to the treatment of fluid flows which are multi-phase, in that they comprise both gas and liquid components, but which are by no means uniformly better mixed or homogenized. A mixture of gas and oil extracted from an onshore or a subsea well, for example, can vary substantially as regards its gas and liquid components. It may comprise slugs of substantially unmixed liquid separated by primarily gaseous portions, as well as portions that are more or less homogeneous. This inconsistency of the nature of the extracted material makes it difficult to handle, in particular by pumping equipment, which could more readily deal with a more homogeneous mixture.

The invention is consequently concerned with conveniently achieving multi-phase fluid flows which are effectively homogenized and accordingly provides a method of and an apparatus for obtaining a homogenized multi-phase fluid flow in a simple and convenient way. It is known from US-A-4 267 052 to aerate a circulating liquid in a vessel having a bottom mixing rotor at the end of a rotatable hollow shaft having openings to the liquid, and to air above the liquid. The shaft includes a venturi nozzle downstream of the liquid opening and a gas tube wherein liquid and gas are mixed by the venturi nozzle in the shaft.

The invention provides an apparatus according to claim 6 and a method according to claim 1.

The liquid flow in the discharge duct can be induced by gravity, the outlet to the discharge duct being then conveniently located in the floor of the vessel or tank. The liquid flow can instead be pump induced or aided and the venturi can then be located directly upstream of a pump unit.

The gas can be drawn from the gas body through an aperture in the roof of the vessel which communicates with the piping by a transverse extension thereof outside the vessel or by way of a chamber mounted on its roof. Alternatively such a supply chamber can be separated from the main volume of the vessel by a suitably apertured internal partition.

Preferably, the apparatus incorporates means tending to ensure that the vessel or container always contains some of both the liquid and the gas components. The invention can accordingly provide that the piping communicating with the discharge duct extends through the pool of liquid in the tank and is provided with apertures or perforations spaced apart along it. Both liquid and gas thus flow together in the piping. The amount or proportion of the gas component which is drawn off from above the liquid thus decreases as a function of an increase of the liquid level, as more of the perforations are submerged. Integral regulation is thus conveniently obtained.

The invention will thus be understood to provide a simple and effective homogenizing method and apparatus, which can operate under gravity in appropriate conditions, without the need for a power input, and which can incorporate automatically operating regulator means.

The invention is further described below, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic sectional view of a mixing or homogenising unit or apparatus embodying the invention; and
Figure 2 graphically illustrates the relationship between the liquid level in the apparatus of Figure 1 and the void fraction drawn off.

The apparatus of Figure 1 comprises a vessel or container 10 of generally upright cylindrical form of which the interior is closed, except for the fluid inlets and the outlets to be described. At the upper region of the cylindrical side wall 11 of the container, there is provided an inlet port 12 communicating by a pipe 14 with a source (not shown) of a multiphase fluid. A liquid outlet port 15 is provided centrally .in the floor 16 of the container 10 and communicates with an outlet or discharge pipe or fitting 17 having an internal constriction 19 which forms a venturi. A gas outlet port 20 in the roof 21 of the container communicates with an upper chamber 22 mounted on the roof. Also communicating with the chamber 22 is a generally vertical pipe 24 extending downwardly from a central aperture 25 in the roof. The pipe 24 extends downwardly through the container interior into the discharge fitting 17, the lower open end 26 of the pipe being located concentrically within the fitting just above the constriction 19 forming the venturi.

The upper portion of the container 10 thus communicates with the pipe 24 by way of the chamber 22 and for a reason explained below, this upper container portion also communicates with the pipe 24 through a series of perforations 27 through the pipe wall. The perforations 27 extend along substantially the entire length of the pipe 24 within the container.

The liquid component of a multi-phase fluid flow entering the container by way of the inlet port 12 tends to separate under gravity from the gaseous component and forms a pool 29 in the lower part of the container. A body of the gaseous component occupies the upper part of the container, above the free surface of the liquid pool.

The liquid component is withdrawn from the pool 29 in the container through the discharge port 15 under gravity, with or without the assistance of a downstream pump 31 connected for example at the lower end of the discharge pipe 17, as schematically shown, and the effect of the venturi is to draw the gas from the upper part of the tank interior through the pipe 24 in admixture with the liquid phase, so that a homogenized or substantially homogenized fluid is obtained in the discharge pipe 17. If the multi-phase fluid flow entering the container interior is already homogenous or

approximately so, then the mixture will be discharged through the pipe 17 by way of both the outlet port 15 and the open end 26.

The void fraction α of the fluid discharged from the container 10 depends on the dimensions of the venturi, and can be made independent of the total flow rate Q^T, the liquid level h in the container, and the absolute pressure.

Assuming that both some liquid and some gas are present in the container, the total pressure drop for the gas and for the liquid phases flowing through it will be equal, and the void fraction from the container can be obtained from the resulting equation as follows:

$$\frac{\rho_L}{2}(1-\alpha)^2 \cdot Q_T{}^2 \left[\frac{(1+\xi_L)}{A_L{}^2} - \frac{1}{A_T{}^2} - \frac{2 \cdot g \cdot h}{(1-\alpha)^2 \cdot Q_T{}^2}\right] = \frac{\rho_G}{2}\alpha^2 \cdot Q_T{}^2 \left[\frac{(1+\xi_G)}{A_G{}^2} - \frac{1}{A_T{}^2}\right]$$

where:

- A_T - the cross-sectional area of the container,
- A_L - the cross-sectional area of the liquid in the venturi,
- A_G - the cross-sectional area of the gas in the venturi,
- ξ_L - the total liquid loss coefficient,
- ξ_G - the total gas loss coefficient,
- ρ_L - the liquid density,
- ρ_G - the gas density, and
- g - gravity.

During steady flow conditions, the average void fraction drawn from the container will equal the average void fraction entering it. To ensure that both liquid and gas are always present in the container, it is convenient to decrease the gas fraction drawn off as the liquid level increases, and vice versa, and this is achieved by the perforations 27 in the pipe 24. The perforated pipe 24 thus acts as an integral regulator allowing a variation in the void fraction.

The relation between the liquid level in the container and the void fraction drawn from it (the mixing unit characteristic) is illustrated in Figure 2. Any desired mixing unit characteristic can be obtained by appropriate choice of dimensions of the venturi and the perforations 27 in the pipe portion 24.

It will be readily appreciated that the invention can be embodied in a variety of ways other than as specifically described and illustrated, within the scope of the claims.

Claims

1. A method of homogenizing a liquid phase and a gas phase of a flowing non-uniform multiphase fluid, the method comprising the steps of:

   a) separating the two phases of the flowing fluid into adjacent gas and liquid bodies within a closed vessel (11) by gravity with the gas phase above the liquid phase;
   b) causing the two phases to flow through a venturi constriction (19) in a duct (17) for mixing and homogenizing the phases of the flowing fluid and to flow away from the vessel by way of an opening (15) in a wall of the vessel, which opening forms an inlet end for the duct (17), and by way of a piping (24) having an inlet end within the vessel interior spaced from the opening (15) and immersed in one phase of the fluid and an outlet end within the duct at or upstream of the venturi constriction (19), whereby the flow of liquid through the venturi constriction creates suction by which the gas is drawn into the liquid flow.

2. A method as claimed in claim 1, wherein the two phases of the fluid flow through the venturi constriction at rates tending to maintain both phases of the flow present within the vessel (11).

3. A method as claimed in claim 2, wherein the two phases of the fluid flow from the vessel in relative amounts dependent on the level of the liquid phase.

4. A method as claimed in claim 1, 2, or 3, wherein the flow of the liquid phase and the gas phase through the venturi constriction is effected by the action of gravity.

5. A method as claimed in claim 4, wherein the flow of the liquid phase and the gas phase through the venturi constriction is assisted by a suction pump (34) communicating with the duct (17) downstream of the venturi constriction.

6. An apparatus for carrying out the process of claim 1 comprising a closed vessel (11) for receiving the non-uniform multiphase flow and for containing the gas and liquid bodies which have been separated under gravity, a duct (17) having a venturi constriction (19) therein for mixing and homogenizing the two phases and a piping (24) having an inlet end (25) and an outlet end (26), the piping outlet end (26) being within the duct at or upstream of the venturi constriction, wherein the vessel (11) has a common inlet (12,14) for the two phases, the duct (17) having an inlet communicating with the interior of the vessel at an opening (15) in a wall of the vessel, and the inlet end of the piping (24) communicates with the vessel interior at a position spaced from the opening (15).

7. An apparatus as claimed in claim 6, wherein the piping (24) extends from the outlet end thereof through the opening (15) and into the vessel (11).

8. An apparatus as claimed in claim 7, wherein the piping (24) extends through the vessel (11) and communicates with the vessel interior by way of a chamber (22) located adjacent the vessel (11) and with which the piping communicates, the chamber being in communication with the vessel.

9. An apparatus as claimed in claim 7 or 8 wherein the piping (24) has a plurality of apertures (27) spaced apart along its length within the vessel (11).

10. An apparatus as claimed in claim 6, 7, 8, or 9, wherein the opening (15) is located in the lower region of the vessel (11).

11. An apparatus as claimed in any one of claims 6 to 10 wherein the outlet end of the discharge duct (17) communicates with the inlet of a suction pump (31).

Patentansprüche

1. Verfahren zur Homogenisierung einer flüssigen Phase und einer Gasphase eines fließenden, ungleichförmigen mehrphasigen Fluids, wobei das Verfahren die folgenden Schritte umfaßt:

   a) Trennen der beiden Phasen des fließenden Fluids in nebeneinanderliegende Gas- und Flüssigkeitsvolumen innerhalb eines geschlossenen Behälters (11) durch Schwerkraft, wobei die Gasphase über der flüssigen Phase liegt;
   b) Leiten der beiden Phasen durch eine Venturiverengung (19) in einem Kanal (17) zum Mischen und Homogenisieren der Phasen des fließenden Fluids und aus dem Behälter durch eine Öffnung (15) in einer Wand des Behälters, wobei die Öffnung ein Einlaßende für den Kanal (17) bildet, und durch eine Rohrleitung (24) mit einem Einlaßende im Inneren des Behälters, das von der Öffnung (15) beabstandet und in eine Phase des Fluids eingetaucht ist, und einem Auslaßende in dem Kanal an oder oberhalb der Venturiverengung (19), so daß durch den Strom der Flüssigkeit durch die Venturiverengung ein Saugdruck erzeugt wird, durch den das Gas in den Flüssigkeitsstrom gesogen wird.

2. Verfahren nach Anspruch 1, wobei die beiden Phasen des Fluids durch die Venturiverengung mit Geschwindigkeiten strömen, die dazu tendieren, beide Strömungsphasen in dem Kessel (11) zu erhalten.

3. Verfahren nach Anspruch 2, wobei die beiden Phasen des Fluids in relativen Mengen je nach dem Stand der flüssigen Phase von dem Behälter fließen.

4. Verfahren nach Anspruch 1, 2 oder 3, wobei der Strom der flüssigen Phase und der Gasphase durch die Venturiverengung durch den Einfluß von Schwerkraft bewirkt wird.

5. Verfahren nach Anspruch 4, wobei der Strom der flüssigen Phase und der Gasphase durch die Venturiverengung durch eine Saugpumpe (34) unterstützt wird, die unterhalb der Venturiverengung mit dem Kanal (17) in Verbindung steht.

6. Vorrichtung zur Durchführung des Verfahrens von Anspruch 1, umfassend einen geschlossenen Behälter (11) zum Empfangen des ungleichförmigen Mehrphasenstromes und zur Aufnahme der Gas- und Flüssigkeitsvolumen, die

unter Schwerkraft getrennt wurden, einen Kanal (17) mit einer Venturiverengung (19) darin zum Mischen und Homogenisieren der beiden Phasen und eine Rohrleitung (24) mit einem Einlaßende (25) und einem Auslaßende (26), wobei sich das Auslaßende (26) der Rohrleitung in dem Kanal an oder oberhalb der Venturiverengung befindet, wobei der Behälter (11) einen gemeinsamen Einlaß (12, 14) für die beiden Phasen aufweist, wobei der Kanal (17) einen Einlaß aufweist, der mit dem Inneren des Behälters an einer Öffnung (15) in einer Wand des Behälters in Verbindung steht, und das Einlaßende der Rohrleitung (24) mit dem Inneren des Behälters an einer von der Öffnung (15) beabstandeten Position in Verbindung steht.

7. Vorrichtung nach Anspruch 6, wobei die Rohrleitung (24) von ihrem einen Auslaßende durch die Öffnung (15) und in den Behälter (11) verläuft.

8. Vorrichtung nach Anspruch 7, wobei die Rohrleitung (24) durch den Behälter (11) verläuft und über eine Kammer (22), die sich neben dem Behälter (11) befindet und mit der die Rohrleitung in Verbindung steht, mit dem Inneren des Behälters in Verbindung steht, wobei die Kammer mit dem Behälter in Verbindung steht.

9. Vorrichtung nach Anspruch 7 oder 8, wobei die Rohrleitung (24) eine Mehrzahl von Durchbrüchen (27) aufweist, die über ihre Länge innerhalb des Behälters (11) voneinander beabstandet sind.

10. Vorrichtung nach Anspruch 6, 7, 8 oder 9, wobei sich die Öffnung (15) im unteren Bereich des Behälters (11) befindet.

11. Vorrichtung nach einem der Ansprüche 6 bis 10, wobei das Auslaßende des Ablaufkanals (17) mit dem Einlaß einer Saugpumpe (31) in Verbindung steht.

Revendications

1. Procédé d'homogénéisation d'une phase liquide et d'une phase gazeuse d'un fluide multiphase non un forme coulant, le procédé comprenant les étapes de:

   a) séparation des deux phases du fluide coulant en des corps gazeux et liquide adjacents à l'intérieur d'un récipient fermé (11) par gravité avec la phase gazeuse par dessus la phase liquide;
   b) écoulement forcé des deux phases à travers une constriction venturi (19) dans une conduite (17) pour mélanger et homogénéiser les phases du fluide coulant et écoulement hors du récipient par une ouverture (15) dans une paroi du récipient, laquelle ouverture forme une extrémité d'entrée du conduit (17), et par une tubulure (24) ayant une extrémité d'entrée à l'intérieur du récipient espacée de l'ouverture (15) et immergée dans une phase du fluide et une extrémité de sortie à l'intérieur du conduit ou en amont de la constriction venturi (19), si bien que l'écoulement du liquide à travers la constriction venturi crée une aspiration par laquelle le gaz est attiré dans l'écoulement du liquide.

2. Procédé selon la revendication 1, dans lequel les deux phases du fluide s'écoulent à travers la constriction venturi à des débits tendant à maintenir la présence des deux phases du fluide à l'intérieur du récipient (11).

3. Procédé selon la revendication 2, dans lequel les deux phases du fluide s'écoulent hors du récipient en des quantités relatives dépendant du niveau de la phase liquide.

4. Procédé selon la revendication 1,2 ou 3, dans lequel l'écoulement de la phase liquide et de la phase gazeuse à travers la constriction venturi est effectué par l'action de gravité.

5. Procédé selon la revendication 4, dans lequel l'écoulement de la phase liquide et de la phase gazeuse à travers la constriction venturi est assisté par une pompe aspirante (34) communiquant avec le conduit (17) en aval de la constriction de venturi.

6. Appareil pour effectuer le procédé de la revendication 1, comprenant un récipient fermé (11) pour recevoir l'écoulement multiphase non uniforme et pour contenir les corps gazeux et liquide qui ont été séparés par gravité, un conduit (17) comportant une constriction venturi (19) pour mélanger et homogénéiser les deux phases et une tubulure (24) ayant une extrémité d'entrée (25) et une extrémité de sortie (26), l'extrémité de sortie de tubulure (26) étant à l'intérieur du conduit au niveau ou en amont de la constriction venturi, dans lequel le récipient (11) a une entrée commune (12,14) pour les deux phases, le conduit (17) ayant une entrée communiquant avec l'intérieur du

récipient au niveau d'une ouverture (15) dans une paroi du récipient, et l'extrémité d'entrée de la tubulure (24) communique avec l'intérieur du récipient à une position espacée de l'ouverture (15).

7. Appareil selon la revendication 6, dans lequel la tubulure (24) s'étend depuis l'extrémité de sortie de celle-ci à travers l'ouverture (15) et dans le récipient (11).

8. Appareil selon la revendication 7, dans lequel la tubulure (24) s'étend à travers le récipient (11) et communique avec l'intérieur du récipient par une chambre (22) située adjacente au récipient (11) et avec laquelle la tubulure communique, la chambre étant en communication avec le récipient.

9. Appareil selon la revendication 7 ou 8, dans lequel la tubulure (24) a une pluralité d'ouvertures (27) espacées sur sa longueur à l'intérieur du récipient (11).

10. Appareil selon la revendication 6, 7, 8 ou 9, dans lequel l'ouverture (15) est située dans la partie inférieure du récipient (11).

11. Appareil selon l'une quelconque des revendications 6 à 10, dans lequel l'extrémité de sortie du conduit de décharge (17) communique avec l'entrée d'une pompe aspirante (31).

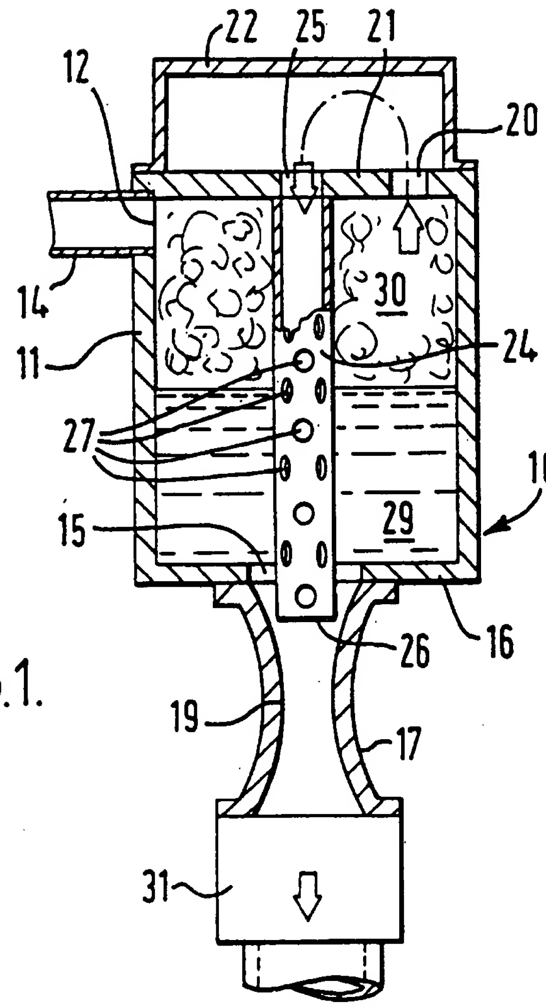
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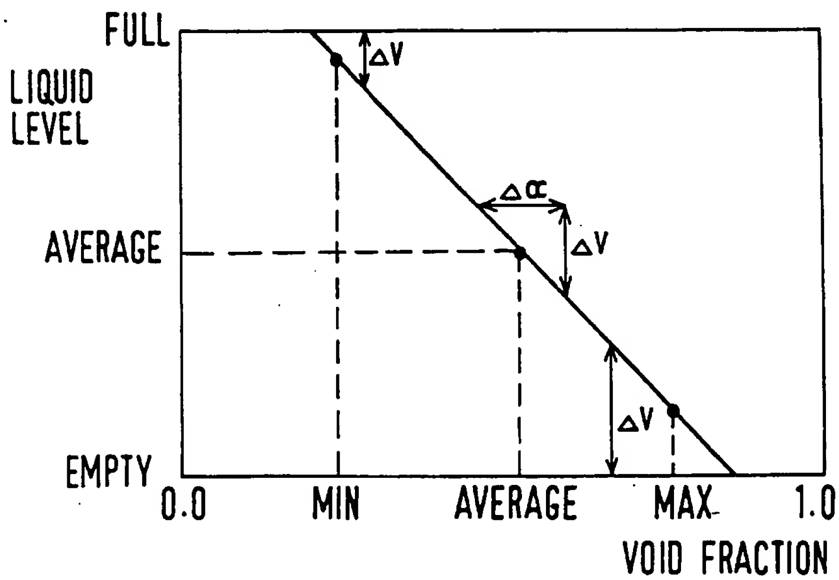
FIG.1.

FIG.2.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